(12) UK Patent Application (19) GB (11) 2 373 158 (13) A

(43) Date of A Publication 11.09.2002

(21) Application No 0105864.3

(22) Date of Filing 09.03.2001

(71) Applicant(s)
Tetra Laval Holdings and Finance S.A.
(Incorporated in Switzerland)
PO Box 430, 70 Avenue Général-Guisan,
CH-1009 Pully, Switzerland

(72) Inventor(s)
Clifford Beveridge

(74) Agent and/or Address for Service
W H Beck, Greener & Co
7 Stone Buildings, Lincoln's Inn, LONDON, WC2A 3SZ,
United Kingdom

(51) INT CL[7]
H05B 6/80 6/72

(52) UK CL (Edition T)
H5H HME HMG HMX

(56) Documents Cited
GB 2354144 A US 5582854 A
US 4592485 A US 4460814 A

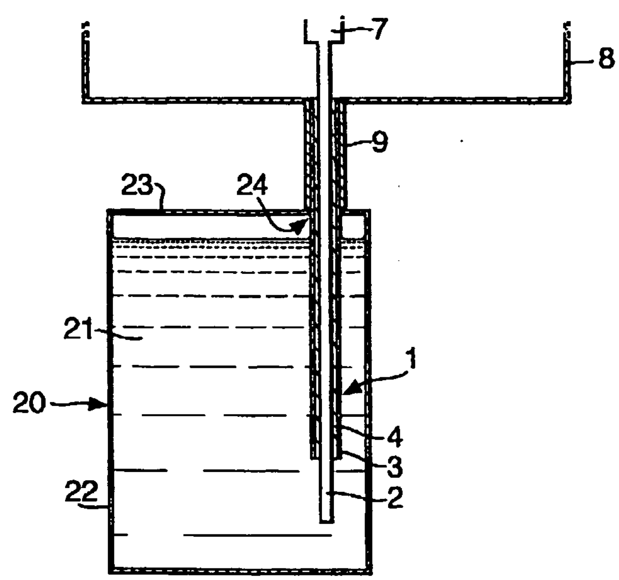
(58) Field of Search
UK CL (Edition S) H5H HMB HME HMG HMX
INT CL[7] H05B 6/72 6/80
Online databases: EPODOC, JAPIO, WPI

(54) Abstract Title

Method and apparatus for heating a food product

(57) A microwave probe 1 is inserted into a food product 21 within a container 20. Microwaves are collected by a collector 7 in a microwave cavity 8, travel along the probe 1, and are transmitted into the food product 21 to heat the product. The probe 1 comprises an inner core 2 and an outer sheath 3 made of food-grade materials such as stainless steel. The core 2 and the sheath 3 are separated by an electrical insulation layer 4 preferably of PTFE. The total length of the probe from the collector to the insertion end is just over a whole number of quarter wavelengths of the microwave radiation used, e.g. 160 mm, and, to ensure efficient launching of the microwaves into the food product 21, the tip of the inner core 2 has an exposed length of at least 10 mm. The container 20 may be an aseptic metal container and the probe may be introduced via a frangible portion to form a hole 24 in the wall 23 of the container. The method finds application in the vending and dispensing of heated food products.

Fig.3.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig.1.

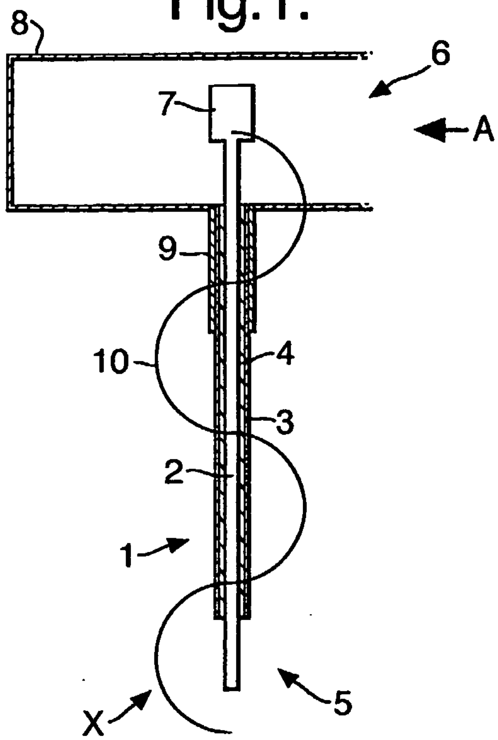


Fig.2.

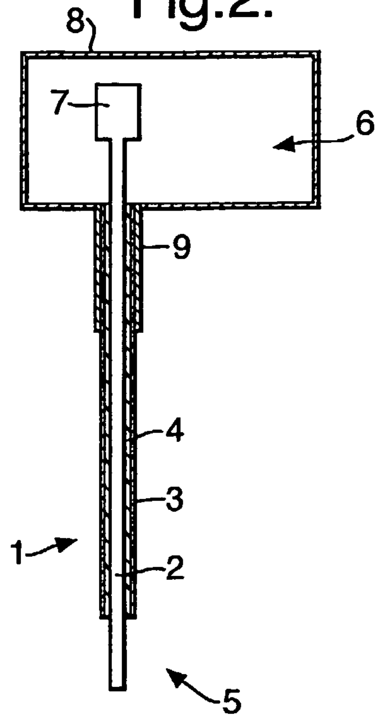


Fig.3.

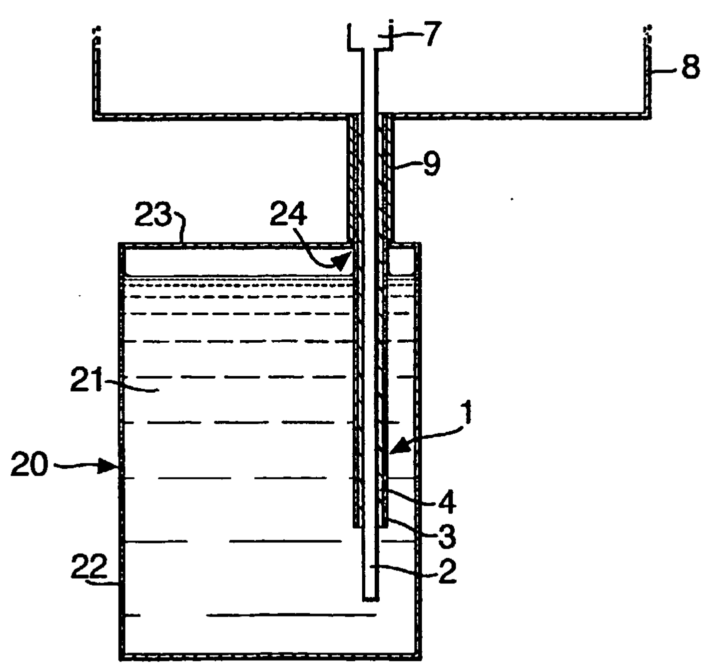


Fig.4.

330 ml

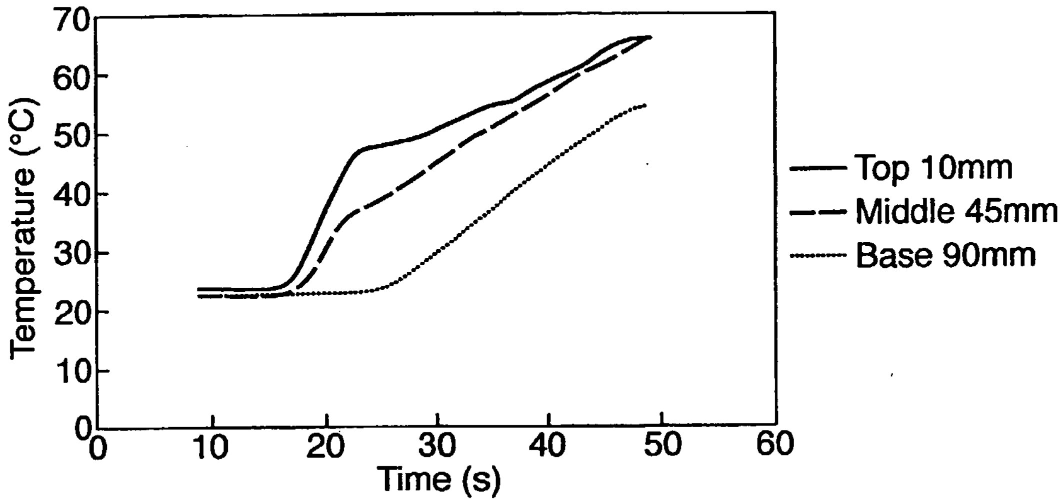


Fig.5.

288 ml

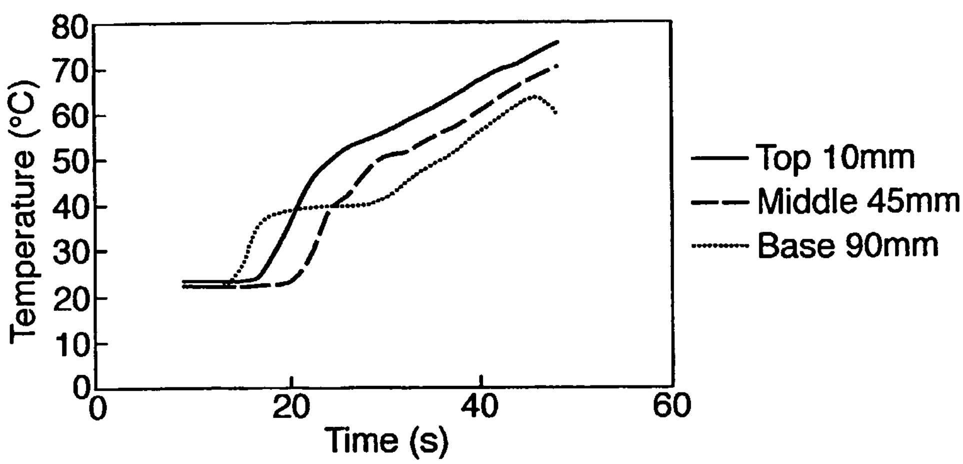
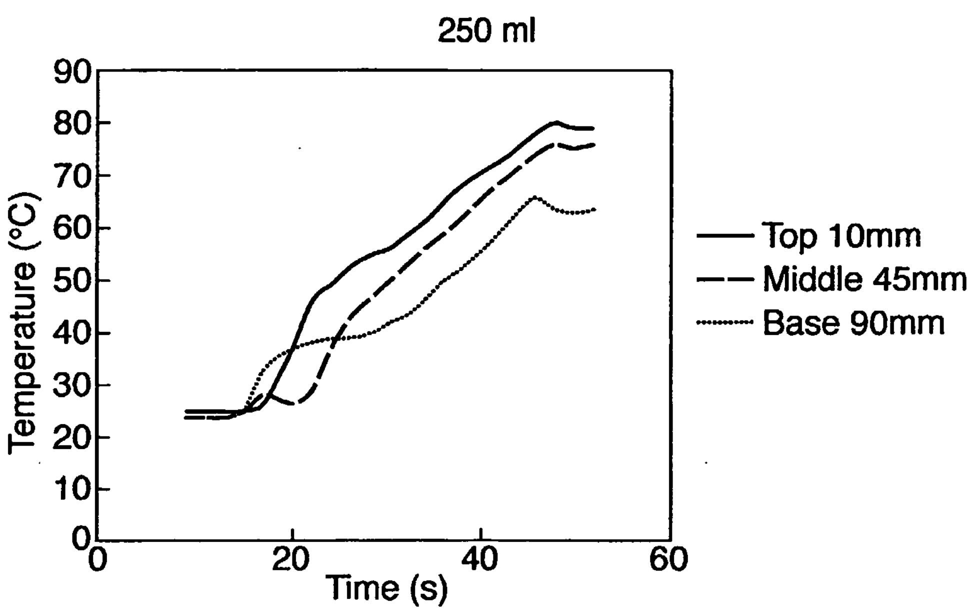


Fig.6.


250 ml
Temperature (°C)
90
80
70
60
50
40
30
20
10
0
0
20
40
60
Time (s)
Top 10mm
Middle 45mm
Base 90mm

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METHOD AND APPARATUS FOR HEATING A FOOD PRODUCT

The present invention relates to a method and apparatus for heating a food product.

There are many instances in which it is necessary or at least desirable to heat a food product just prior to its consumption by a consumer. It should be understood that in this specification, the phrase "food product" or similar should be construed broadly to include any ingestible product including for example tea, coffee and other drinks such as hot chocolate, soup, etc.

In one known dispensing apparatus, a heated liquid food product is delivered to the consumer by virtue of the apparatus pouring hot water onto the dehydrated food product just prior to delivery to the consumer. However, it is well known that food products which are dehydrated and then rehydrated in this manner tend to be less palatable than otherwise and, furthermore, it often happens that the dehydrated food product does not fully dissolve when hot water is added, which is unpleasant for the consumer.

Accordingly, it would be preferable to provide apparatus in which a fully constituted food product (i.e. one which has not previously been dehydrated) can be heated just prior to consumption by a consumer. Various techniques are available for heating such a food product. In one, known as "ohmic heating", an electric current is passed between two or more electrodes that are immersed in the food product in order to heat the food product. However, this technique only works for some food products,

namely those that have neither too little nor too great an electrical conductivity. As an alternative, the use of microwaves is in principle very convenient. Typically, a microwave oven can be used in which the food product is placed within a chamber and irradiated from outside by microwaves produced by the microwave oven. However, a problem with any microwave oven is in preventing microwaves leaking out, especially in so-called combination ovens which include other elements such as an electrical heater, thermometer, etc., such additional elements often acting as wave guides to carry microwaves out of the oven.

The applicant's known aseptic containers or cartons for liquid food products are internally lined with a metal foil in order to ensure that the contents of the container are not spoiled by storage in bright light and further to ensure that the integrity of the container is retained until the food product is to be consumed. However, the metal foil completely prevents microwaves entering the container from outside. Separately, the nature of the container is such that many other known heating techniques cannot be used whilst the food product is in the container. Moreover, many other food products are provided by manufacturers in other types of metal or metal-lined containers, including for example metal cans, metal foil trays, etc. Thus, in order to heat a food product provided in such containers, previously it would have been necessary to open the container and decant the food product into some suitable receptacle in which the food product can be heated. This would however prevent rapid dispensing of the heated food product and also means that there is a receptacle that has to be cleaned before it can be used again to enable a further food product to be heated.

According to a first aspect of the present invention, there is provided a method of heating a food product in a container, the method comprising the steps of: inserting a microwave probe into the food product within the container; and, heating the food product by passing microwaves along the probe to cause microwaves to be transmitted into the food product within the container.

According to a second aspect of the present invention, there is provided a method of dispensing a heated food product, the food product being contained in a container, the method comprising the steps of: inserting a microwave probe into the food product within the container; heating the food product by passing microwaves along the probe to cause microwaves to be transmitted into the food product within the container; and, dispensing the container and heated food product.

The method of each aspect allows a food product to be heated *in situ* in its container, regardless of the nature of the container as such. Metal or metal-lined containers can therefore be used to contain the food product during transport and storage. The method avoids the need to dispense the food product into another container merely to allow the food product to be heated. Heating of the food product to a suitable temperature can be very rapid. The arrangement can be such that leakage of microwaves is minimised or practically eliminated. The method allows a wide variety of food products to be heated. The only requirement is that the food product be of the type that heats on being irradiated with microwaves. Typically, any food product containing water, or at least a sufficient amount of water, can be heated in this manner.

In a particularly convenient arrangement, the container has a frangible region that provides an opening to the container when broken, wherein, in the insertion step, the microwave probe enters the container through such opening. Preferably, in the insertion step, the leading end of the microwave probe is caused to break the frangible portion and enter the container through the opening. In this preferred arrangement, the frangible portion allows the microwave probe to be inserted easily into the container and avoids the need to provide some mechanism solely for opening the container to allow the microwave probe to be inserted. The frangible portion in such a container may be of the type that provides a hole for insertion of a drinking straw, as in the applicant's well known aseptic containers referred to above. Alternatively, the frangible portion may be broken by some means other than the microwave probe in order to open the container. For example, the container may have a "pull tab" or similar that is first removed to reveal an opening to the container through which the microwave probe is inserted.

Preferably, the container is in a sealed condition prior to insertion of the microwave probe. In the most preferred arrangement, the insertion of the microwave probe breaks the seal. This ensures that the food product remains sterile or practically sterile for the longest possible time.

The container may be metal or metal-lined. As noted above, the present invention allows containers of almost any material to be used. This means that metal or metal-lined containers can be used, thus allowing the known advantages of such containers to be retained. Moreover, using a metal or metal-lined container is advantageous in that it tends to contain microwaves within the container, thus preventing leakage of the microwaves, and so providing

a safe heating method, and may help to provide for more rapid heating of the food product.

The microwave probe preferably comprises an inner electrically conductive core, an outer electrically conductive sheath, and an insulating layer therebetween, wherein, in the insertion and heating steps of the method, the microwave probe is inserted into the container such that the outer electrically conductive sheath penetrates the container. This helps to minimise or prevent altogether leakage of microwaves during the heating step.

At the insertion end of the microwave probe the inner electrically conductive core preferably projects beyond the end of the insulating layer and beyond the end of the outer electrically conductive sheath. This arrangement enables a high efficiency to be achieved for the transfer of microwaves into the food product.

Ideally, the insulating layer would consist of air. In practice, it is preferable to provide some way of ensuring that the outer sheath and inner core are separated at all times to ensure that there is no shorting. It is also preferable to provide some way of preventing food product passing up between the outer sheath and the inner core. This is conveniently provided by a tangible insulating layer. In an example, the insulating layer is solid, whether along the whole length of the probe between the inner core and outer sheath or for example provided as one or more discrete discs along the length of the probe between the inner core and outer sheath. As another alternative, the insulating layer may be in the form of a foam. The insulating layer may be composed of PTFE. PTFE is preferred as it is a good electrical insulator but also a good transmitter of microwaves.

According to a third aspect of the present invention, there is provided apparatus for heating a food product in a container, the apparatus comprising: a microwave probe capable of being inserted into a food product within an initially sealed container; and, a source of microwaves for heating a said food product by passing microwaves along the probe when inserted into a said food product within a said container to cause microwaves to be transmitted into a said food product.

According to a fourth aspect of the present invention, there is provided apparatus for dispensing a heated food product contained in container, the apparatus comprising: a microwave probe capable of being inserted into a food product within an initially sealed container; a source of microwaves for heating a said food product by passing microwaves along the probe when inserted into a said food product within a said container to cause microwaves to be transmitted into a said food product; and, a dispensing arrangement for dispensing a said container and heated food product.

There may be at least one container having a frangible region that provides an opening to the container when broken, the apparatus comprising a mechanical moving arrangement for moving the microwave probe relative to the container such that in use the microwave probe enters the container through such opening. Preferably, the mechanical moving arrangement is such that the leading end of the microwave probe is caused to break the frangible portion and enter the container through the opening. Alternatively, means may be provided for opening the container prior to insertion of the microwave probe.

The container is preferably in a sealed condition prior to insertion of the microwave probe.

The container may be metal or metal-lined.

The microwave probe preferably comprises an inner electrically conductive core, an outer electrically conductive sheath, and an insulating layer therebetween, the mechanical moving arrangement preferably being such that in use, the microwave probe is inserted into the container such that the outer electrically conductive sheath penetrates the container.

At the insertion end of the microwave probe the inner electrically conductive core preferably projects beyond the end of the insulating layer and beyond the end of the outer electrically conductive sheath.

The insulating layer may be composed of PTFE.

An embodiment of the present invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a schematic longitudinal cross-sectional view of an example of a microwave probe for use in the present invention;

Fig. 2 is a schematic transverse cross-sectional view of the microwave probe of Figure 1;

Fig. 3 is a schematic cross-sectional view of an example of a container and food product having a microwave probe inserted therein; and,

Figures 4 to 6 show schematically plots of heating curves for three different size containers.

Referring to Figures 1 and 2, an example of a microwave probe 1 has an electrically conductive core 2 and an annular electrically conductive outer sheath 3 with an annular electrically insulating layer 4 positioned therebetween. The inner core 2, outer sheath 3 and insulating layer 4 are preferably all elongate and cylindrical and coaxially arranged. In the example shown, the inner core 2, outer sheath 3 and insulating layer 4 are all of circular cross-section, though other cross-sectional shapes are possible and indeed may be preferred.

As discussed above, it is convenient that the insulating layer 4 be of solid material so as to maintain the spaced separation between the inner core 2 and outer sheath 3 and also to prevent food product from passing between the inner core 2 and outer sheath 3 in use. A particularly suitable material for the insulating layer 4 is PTFE as it is electrically insulating but a relatively good transmitter of microwaves. As an alternative, it may be possible to use polypropylene though it is less able to withstand high temperatures. Other configurations for the insulating layer 4 are possible, as discussed above.

The inner core 2 and the outer sheath 3 are each preferably integrally formed, without junctions, so as to ensure good transfer of microwaves along the probe 1. The inner core 2 and outer sheath 3 are preferably made of food-grade materials, such as for example stainless steel. Thus, in the preferred embodiment, the inner core 2 and outer sheath 3 are each preferably turned from a solid block of stainless steel.

The probe 1 has an insertion end 5 and a microwave collector end 6. At the collector end 6, the inner core 2 is provided with an integrally formed collector 7 that is wider than the body of the inner core 2. In the example shown, the collector is cylindrical but in practice, another shape, such as spherical, may be more efficient. The collector 7 is located within a microwave cavity 8 which receives microwaves from a source (not shown) in the direction indicated by A. By appropriate tuning of the microwave cavity 8, microwaves are efficiently collected by the collector 7 and passed down the microwave probe 1 to the insertion end 5 of the probe 1.

A pipe clamping arrangement 9 for clamping the microwave probe 1 to the microwave cavity 8 is also shown schematically in Figures 1 and 2.

In Figure 1, the waveform 10 for standing wave microwave radiation emitted by the probe 1 is indicated schematically. As is conventional, the preferred frequency for the microwave radiation is 2.45 GHz. By appropriate dimensioning of the microwave probe 1 and its individual components, an anti-node X in the standing wave formed by the microwave radiation can be caused to exist close to the tip of the microwave probe 1 at the insertion end 5. In the preferred embodiment, this anti-node X is formed at a point just short of the end of the microwave probe 1. Given that the anti-node X is formed at a whole number of quarter wavelengths along the probe 1 from the collector 7, the total length of the microwave probe 1 from the body of the collector 7 to the tip of the probe 1 at the insertion end 5 should be just over a whole number of quarter

wavelengths of the microwave radiation used. In an example, this total length may be approximately 160mm.

Furthermore, in order to ensure efficient launching of microwaves into the food product, the inner core 2 is preferably exposed by extending beyond the end of the outer sheath 3 and insulating layer 4. The exposed tip of the inner core 2 preferably has an exposed length of at least 10mm. This eliminates most of the reflectance that cannot be tuned out by appropriate dimensioning and arrangement of the microwave cavity 8 and ensures efficient launching of microwaves into the food product 21. It is preferred that the insertion end 5 of the probe 1 be positioned as close to the bottom of the container 20 as possible given that convection currents will drive warmed food product 21 upwards. In one example, the inner core 2 projects beyond the end of the outer sheath 3 and insulating layer 4 by a distance of 20mm. Given a length of 80mm for the outer sheath 3 and insulating layer 4 up to the free end of the clamping arrangement 9, the probe 1 of this example has an overall immersion depth of 100mm.

Referring now to Figure 3, there is shown schematically the microwave probe 1 inserted into a container 20 which contains a food product 21. Preferably, for ease of use and to facilitate insertion of the probe 1 into the food product 21, the food product 21 is a liquid. It should be mentioned that having a low viscosity for the food product 21 helps to prevent localised boiling occurring around the exposed tip of the inner core 2 of the microwave probe 1 because convection currents built up in the food product 21 during heating drive heated food product away from the exposed tip of the inner core 2.

Localised boiling in the food product 21 is preferably avoided both to prevent the food product 21 from being spoiled and to prevent arcing and back-reflectance of the microwave energy from the food product 21. A mechanism (not shown) is provided for moving the microwave probe 1 relative to the container 20 so as to allow the probe 1 to be inserted into and withdrawn from the container 20 as required.

The container 20 is conveniently of the type described above, namely the applicant's known aseptic container or carton for liquid food products which are internally lined with a metal foil lining 22. As mentioned above, a metal foil lining 22 or an entirely metal container helps to contain microwaves within the container. This helps to prevent microwaves from leaking out in use and also may promote more rapid heating of the food product 21. In order further to reduce or eliminate microwave leakage, it is preferred that the outer sheath 3 be long enough so that it penetrates the container 20 in use, as shown.

The applicant's known aseptic containers or cartons mentioned above, and some other known containers, are provided with a frangible portion, typically in the form of a partly perforated small circle in one end wall 23 of the container 20. In use in one preferred arrangement, the container 20 is positioned relative to the probe 1 so that the leading tip at the insertion end 5 of the probe 1 breaks this frangible portion to form a hole 24 in the wall 23 of the container 20 to allow the probe 1 to be inserted into the container 20 and into the body of the food product 21. After the food product 21 has been heated and the probe 1 withdrawn, the consumer is presented with the hole

24 ready to act as a straw hole through which a drinking straw can be passed so as to allow the heated food product 21 to be consumed.

It may be that a separate opening mechanism is provided to break open the frangible portion to provide the hole 24, rather than using the probe 1 to open the container 20. Similarly, the container may be of the type that has a pull tab or similar which can be removed by a separate opening mechanism prior to insertion of the probe 1 through the hole thereby formed.

Whilst the present invention in its broadest aspect has many applications, it is envisaged that it will be particularly useful in a dispensing or vending apparatus at a point-of-supply or point-of-purchase. (It will be understood that for example many employers provide drink dispensing machines for use by staff for free and thus, in this context and sense, no distinction between "dispense" and "vend" and similar expressions is intended.) A consumer selects a food product to be dispensed/purchased. An appropriate mechanism within the dispensing apparatus selects a container 20 containing the selected food product 21 and causes the microwave probe 1 to be inserted into the container 20 as discussed above. Microwave energy is applied via the probe 1 into the body of the food product 21 for a predetermined period of time and/or until a predetermined temperature for the food product 21 has been achieved. The microwave probe 1 is then withdrawn and the heated food product 21 dispensed in its container 20 to the consumer. The dispensing/vending apparatus preferably has means for cleaning the exterior surfaces of the probe 1 after use.

The results of experiments using the probe 1 discussed above are shown schematically in Figures 4 to 6. In Figure 4, there is shown a plot of temperature versus time measured at three different points within a 330ml container containing, in this example, cranberry juice. An average temperature rise of approximately 36°C was achieved within 30 seconds. Referring to Figure 5, showing a corresponding plot for a 288ml container containing blackcurrant squash, an average temperature rise of almost 39°C was achieved in 30 seconds. Referring to Figure 6, showing a corresponding plot for a 250ml container containing blackcurrant squash, an average temperature rise of just over 44°C was achieved in 30 seconds. Overall, heating efficiency was in the range of approximately 85 to 90 percent or higher. It will be appreciated that faster heating can be achieved by use of a higher power source of microwaves.

An embodiment of the present invention has been described with particular reference to the examples illustrated. However, it will be appreciated that variations and modifications may be made to the examples described within the scope of the present invention. For example, in the example shown, there is a fairly sharp transition in the region where the inner core 2 protrudes beyond the outer sheath 3 and insulating layer 4. This sharp transition may make it difficult to clean the probe 1. The space around this transition may therefore be filled in with for example a conical piece of the insulating material. As another variation, the whole probe 1, or at least that portion that is inserted into the container 20, may be encapsulated within an envelope of insulating material, such as for example PTFE.

CLAIMS

1. A method of heating a food product in a container, the method comprising the steps of:

inserting a microwave probe into the food product within the container; and,

heating the food product by passing microwaves along the probe to cause microwaves to be transmitted into the food product within the container.

2. A method of dispensing a heated food product, the food product being contained in a container, the method comprising the steps of:

inserting a microwave probe into the food product within the container;

heating the food product by passing microwaves along the probe to cause microwaves to be transmitted into the food product within the container; and,

dispensing the container and heated food product.

3. A method according to claim 1 or claim 2, wherein the container has a frangible region that provides an opening to the container when broken, wherein, in the insertion step, the microwave probe enters the container through such opening.

4. A method according to claim 3, wherein, in the insertion step, the leading end of the microwave probe is caused to break the frangible portion and enter the container through the opening.

5. A method according to any of claims 1 to 4, wherein the container is in a sealed condition prior to insertion of the microwave probe.

6. A method according to any of claims 1 to 5, wherein the container is metal or metal-lined.

7. A method according to any of claims 1 to 6, wherein the microwave probe comprises an inner electrically conductive core, an outer electrically conductive sheath, and an insulating layer therebetween, wherein, in the insertion and heating steps, the microwave probe is inserted into the container such that the outer electrically conductive sheath penetrates the container.

8. A method according to claim 7, wherein at the insertion end of the microwave probe the inner electrically conductive core projects beyond the end of the insulating layer and beyond the end of the outer electrically conductive sheath.

9. A method according to claim 7 or claim 8, wherein the insulating layer is composed of PTFE.

10. Apparatus for heating a food product in a container, the apparatus comprising:

a microwave probe capable of being inserted into a food product within an initially sealed container; and,

a source of microwaves for heating a said food product by passing microwaves along the probe when inserted into a said food product within a said container to cause microwaves to be transmitted into a said food product.

11. Apparatus for dispensing a heated food product contained in container, the apparatus comprising:

a microwave probe capable of being inserted into a food product within an initially sealed container;

a source of microwaves for heating a said food product by passing microwaves along the probe when inserted into a said food product within a said container to cause microwaves to be transmitted into a said food product; and,

a dispensing arrangement for dispensing a said container and heated food product.

12. Apparatus according to claim 10 or claim 11, and comprising at least one container having a frangible region that provides an opening to the container when broken, the apparatus comprising a mechanical moving arrangement for moving the microwave probe relative to the container such that in use the microwave probe enters the container through such opening.

13. Apparatus according to claim 12, wherein the mechanical moving arrangement is such that the leading end of the microwave probe is caused to break the frangible portion and enter the container through the opening.

14. Apparatus according to claim 13, wherein the container is in a sealed condition prior to insertion of the microwave probe.

15. Apparatus according to claim 13 or claim 14, wherein the container is metal or metal-lined.

16. Apparatus according to any of claims 13 to 15, wherein the microwave probe comprises an inner electrically conductive core, an outer electrically conductive sheath, and an insulating layer therebetween, wherein the mechanical moving arrangement is such that in use, the microwave probe is inserted into the container such that the outer electrically conductive sheath penetrates the container.

17. Apparatus according to claim 16, wherein at the insertion end of the microwave probe the inner electrically conductive core projects beyond the end of the insulating layer and beyond the end of the outer electrically conductive sheath.

18. Apparatus according to claim 16 or claim 17, wherein the insulating layer is composed of PTFE.

19. A method of heating a food product in a container, substantially in accordance with any of the examples as hereinbefore described with reference to and as illustrated by the accompanying drawings.

20. Apparatus for heating a food product in a container, substantially in accordance with any of the examples as hereinbefore described with reference to and as illustrated by the accompanying drawings.

21. A method of dispensing a heated food product contained in a container, substantially in accordance with any of the examples as hereinbefore described with reference to and as illustrated by the accompanying drawings.

22. Apparatus for dispensing a heated food product contained in a container, substantially in accordance with any of the examples as hereinbefore described with reference to and as illustrated by the accompanying drawings.

Application No:	GB 0105864.3	**Examiner:**	Bill Riggs
Claims searched:	1 - 22	**Date of search:**	26 September 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): H5H (HMB, HME, HMG, HMX)

Int Cl (Ed.7): H05B (6/72, 6/80)

Other: Online databases: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2354144 A	(Merrychef Ltd.) see particularly abstract	1, 6
X	US 5582854 A	(Ajinomoto Co. Inc.) see particularly fig.3 and col. 12 ll.22-43	1, 2, 10, 11 at least
A	US 4592485 A	see whole document	
X	US 4460814 A	(Amana Refrigeration Inc.) see particularly figs.	1, 6

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		